ABSTRACT

Personal Computers and Blissymbolics

This paper is written for Blissymbol users, to acquaint them with developments, throughout the seventies which make feasible the utilization of personal computers to display Blissymbolics. An introduction and guide is given for the Blissymbol user considering the acquisition of a personal computer and projections are made as to future developments in Blissymbol communication using computer technology. Information is presented relating to the graphic capabilities of several currently available personal computers and examples of Blissymbols are included. The focus of the paper is upon the need for Blissymbol users to learn about a technology which has the potential for providing exciting new educational, avocational and vocational opportunities.

by Shirley McNaughton

PERSONAL COMPUTERS

AND

BLISSYMBOLICS

by

Shirley McNaughton

April, 1981

Reference Notes

1. McLean, R.S. Description of Course 1517, O.I.S.E., Summer, 1979.

2. Drake, R. Blissymbolics on the Pet Microcomputer. Paper in preparation. April, 1980, Brantford, Ontario.

3. Vanderheiden, G.C. Comparison of the Apple II and TRS-80 Microcomputers in Rehabilitation Applications. Available from author, TRACE Center, University of Wisconsin, Madison.

4. Papp, R., Bell-Northern Research, P.O. Box 3511, Station C, Ottawa, Ontario, K1Y 4H7.

Personal Computers and Blissymbolics

This paper is written for Blissymbol users by a Blissymbol instructor. It is written because there is much needing to be said. Those interested in the welfare of Blissymbol users are invited to read along.

During the seventies, dramatic developments have occurred in four areas, which together have the potential for profoundly influencing the future lifestyles of physically handicapped non-speaking persons:

1. Blissymbolics - Following its introduction at the Ontario Crippled Children's Centre in 1971, Blissymbolics has been successfully applied in over 14 countries[1] as a communication system for communicatively impaired and disadvantaged persons (Kates & McNaughton, 1975; Silverman, McNaughton & Kates, 1978; McNaughton, 1978; McNaughton & Kates, 1980). Blissymbolics was originally designed by Charles K. Bliss in the nineteen-forties, as an international language (Bliss, 1965). It would seem as if it were created "before its time," for little attention was given to this powerful system prior to its application in Toronto in 1971. Resulting from its growth in the seventies however, by 1979 there were an estimated 20,000 users in North America, Great Britain and the Scandinavian countries, as well as beginning programs in many other parts of the world. This graphic meaning-based communication system had become an internationally recognized augmentative to speech for non-speaking persons. This widespread specialized usage created a demand for instructional materials and led to the development of Blissymbol displays, stick-on-stamps, technical aids and publications to support its application.[2] Of particular importance is the recent publication of Blissymbols for Use (Hehner, 1980). This book provides a symbol classification system through the introduction of a Blissymbol alphabet and groups over 1300 Blissymbols by semantic categories. The seventies demonstrated the value of Blissymbolics as a communication system and brought the system to a level of organization which made it ripe for computer application. The strengths of the system for computer usage have only begun to be discovered, but Blissymbolics' reliance on meaning and its independence from any spoken language make it a communication medium with excellent potential within a computer-communications system. Thompson (1978) in advocating computer use of an iconic or ideographic language says, "Computers can teach ideographic languages as easily as ordinary teachers can teach the phonetic forms of writing " (p. 46). He claims that the "overall storage and transmission costs for a complete document would be significantly reduced for ideographic material in comparison with the same content using conventional phonetic format." (p. 48), and imagines a new era of communication in which

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[1] Australia, Canada, Denmark, Finland, France, the Netherlands, Iceland, India, Israel, New Zealand, Norway, Sweden, U.K., U.S.A. (Bulletin, V, #1, 1979, BCI).

[2] A full list of current materials can be obtained from the Blissymbolics Communication Institute, 350 Rumsey Road, Toronto, Ontario, Canada.

"symbol could transform into symbol, with a flow and rhythm set by the author" and in which "ideographic writing is Bliss!" (p. 49).

2. Personal Computers - The miniaturization of electronics through the development of the tiny semiconductor chip has made "personal computing" a reality. A personal computer is one "that is marketed and priced so that an individual could reasonably be expected to have exclusive use and perhaps ownership of it." (McLean, 1979, Note 1)

   It is difficult for the novice to fully comprehend the mammoth changes which occurred during the seventies in the way in which computers were produced and the resulting transformation in the computer industry. Key to the development is the chip, an integrated circuit "in which several active transistor elements are formed on a thin silicon layer and the pattern of interconnections (is) established by photo-engraving a conducting film of evaporated metal." "Each year since 1960, the number of components that could be formed on a single silicon chip doubled." "By 1970, the era of large-scale integration had arrived and one thousand components could be grown on a silicon chip less than a quarter-of-an-inch square"; by 1978, the number of components was approaching one hundred thousand. Each individual chip (less than a quarter-of-an-inch square) now executes about a million instructions per second and is the equivalent of a small computer (Gotlieb, 1978, p. 3). As manufacturing techniques improved, the cost came down drastically, making possible the first personal computers in 1977.

   Between 1977 and 1980, the types of personal computers have grown from two, the PET by Commodore and TRS 80 by Radio Shack to a range best encompassed by listing the types of central processing units used: 8080s, 6502s, Z80s, 8085s, 6800s, 6809s. As Carl Helmers in a BYTE editorial (January, 1980) says, "The user is King." A demonstration of the expansion in just three years: in 1977, the personal computers offered 8000 (8K) bytes of memory; in 1980, the personal computer is available with 64K bytes of memory. Leaps in technology of this dimension have occurred in many aspects of the personal computer.

3. Communications Technology - Radical changes have also taken place in the technology associated with communications: in the channels over which messages are sent (coaxial cable, microwave links, optical fibres); in the mode of transmission (shift from analogue to digital transmission, allowing more effective use of the channel and greatly reducing signal distortion); in the development of switching procedures which utilize computers and which more effectively "route" information; in the use of satellites to transmit messages over long distances. As the sending and sharing of information became faster and easier, the cost became less dependent upon distance and the home became a valid setting for inclusion in the communications network. (Gotlieb, 1978)

4. Expectations and Rights of Non-speaking Physically Handicapped Persons - Throughout the seventies, as technology has been applied to

> providing non-speaking physically handicapped persons with greater independence of mobility and communication, their intellectual, social, emotional and communication needs have become better recognized. The successful use of Blissymbolics has contributed to a growing awareness of their rights to educational, vocational and avocational opportunities and many professionals are working toward the implementation of appropriate delivery services. (Fulenberg & Vanderheiden , 1978; Lundman, 1978; Vanderheiden & Grilley, 1976; Preston, 1979.) The Blissymbol user has been led to expect that his/her communication capability will continue to grow and that he/she will participate in the communications systems of his/her society.

Within the context of this new information technology, the ability to speak, to commute, or to independently function in society is much less relevant than the ability to plan, construct, and receive meaningful messages using a visual medium. The Blissymbol user may just have a slight edge!

It is time that the aspirations and communication capabilities of Blissymbol users be applied to the communications capability of the merged computer and communications industries. An information bridge is needed. To this end, the following introduction and guide to personal computers for Blissymbol users is offered.

Guide to Personal Computers

In considering the acquisition of a personal computer, give attention to six areas:

A. Learn about computers;

B. Compare the capabilities of various personal computers;

C. Consider the long term objectives for your use of the personal computer;

D. Study the requirements of the system of Blissymbolics;

E. Decide upon the quality and level of resolution, the size, number and capabilities of Blissymbolics desired;

F. Discover the extent of usage of particular personal computers within your geographical region.

A. Learn About Computers

Several activities are recommended. If at all possible, see the BBC film, The Chips are Down for an overview of the history of computer technology and the impact of "the chip" on society as a whole. Recommended for reading and studying is Basic and the Personal Computer by T. Dwyer and M. Critchfield (1978). As well, visit several computer stores and talk to personal computer users.

You will discover that a computer is made up of five units:

1. central processing unit;
2. control unit;
3. memory unit;
4. input unit;
5. output unit (Diagram One).

You will want to ask questions related to these units, so learn what they do.

1. The central processing unit (CPU) directs how the computer will function. It dictates how information will be manipulated. It consists of a "motherboard" with a network of printed wires soldered to connectors, called "slots", that accept several circuit boards called modules. The "heart" of the CPU board is the microprocessor chip. Also essential to its functioning is the "clock" circuitry synchronizing all the activities. To expand the computers processing capabilities, new modules can be added up to the capacity (both slots and power) of the particular computer.

2. The control unit consists of two kinds of programs: (1) those called "software" which are entered by the computer user and come to the control unit through the memory unit in which they are stored, and (2) those which are called "firmware" which are either built into the original system or added directly to the control unit (e.g. through adding modules or plug-in ROM cassettes). The latter are stored in ROMs, Read Only Memory devices, and cannot be modified by the user. The former (software) utilize RAM (Random Access Memory) and are accessible both for use and adaptation by the user. The control unit through its software and firmware give information to the CPU to allow it to operate effectively.

3. The memory unit houses software programs and data which is being processed. This memory accommodates RAM and because it can be randomly accessed, allows the CPU to record and acquire (write and read) information quickly and as it is needed. RAM can be expanded through storage peripherals (additional equipment) in the form of tape cassettes and magnetic disk memories.

4. The Input Unit allows information, control signals and software to enter the computer. The keyboard, control switches, tape cassette, floppy disk, all connect to the computer through the input unit.

5. The Output Unit provides the route for processed information to leave the computer and be presented on a T.V. screen, printer, or tape cassette; to control environmental systems; or to be transmitted on a telephone line.

B. Compare the Capabilities of Various Personal Computers

You will need to make specific enquiries and compare the personal computers available in your community with regard to:

- the control unit and its ROM, as it relates to the graphic capabilities of each computer (see Table III).
- the memory unit and its RAM, with regard to:
  (1) the space available within the computer to accept programs from storage peripherals (see Table I);
  (2) the number and type of software programs which are available or which can be developed.
- the input and output unit, as to the type, number and cost of peripherals it can accommodate. You should keep in mind that the capability of the personal computer to be operated by personalized controls is limited only in the sense that it may not be built in. Through the work of experienced hobbyists, any personal computer can be adapted to accommodate a variety of switch-interface mechanisms (see Table II).

Insert Table I Here

Insert Table II here

C. Consider the Long Term Objectives for Your Use of the Personal Computer

The capabilities of the personal computer seem to be limited only by one's imagination. To the non-speaking physically handicapped person, they offer a communication display, an educational tool, a word processor, synthesized

speech, a device for creating Blissymbols and new ways of transmitting messages, a recreational instrument offering games, music and art activities, a method of controlling various environmental systems, an interface to the telephone, a vocational pursuit, and a link to a broad communication system. Suggested articles for reading are listed in Appendix A.

D. Study the Requirements of the System of Blissymbolics

Since Blissymbolics is a system in which the physical characteristics of the symbols relate directly to the meaning represented by the symbol,

, you must review the subtle differences in shape which lead to major differences in meaning. To effectively display the system of Blissymbolics, the personal computer must have the capability of graphically dealing with the distinguishing features of Blissymbol shapes.

* * *

(A) The Blissymbolics "alphabet" introduced in Blissymbols for Use (Hehner, 1980), offers a classification system for examining Blissymbols according to their physical configuration. All Blissymbols can be analyzed into the following alphabet shapes:

The first requirement of the personal computer is that ALL THE SHAPES CONTAINED IN THE BLISSYMBOLICS ALPHABET CAN BE DISPLAYED.

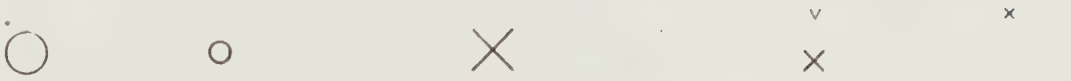
* * *

(B) Several factors relating to the presentation of the Blissymbolics alphabet shapes are important in denoting different meanings within Blissymbolics. The following can be thought of as distinctive features critical to accurate

meaning representation:

1. Size of alphabet shape e.g.

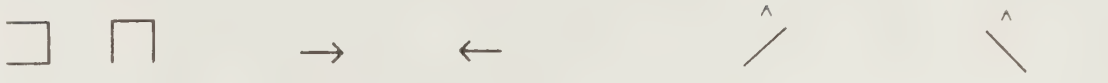
e.g.



sun mouth multiplication much, many plural

2. Direction or orientation of alphabet shape

e.g.



room door forward backward (to) cross out destroy (to) write

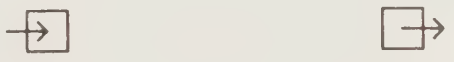
3. Position of alphabet shape with regard to earth and skyline

e.g.

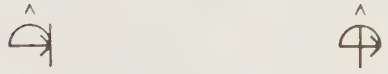
beach water cloud

4. Positioning of alphabet shapes with regard to each other.

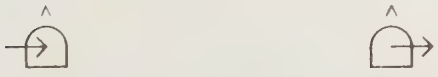
e.g.



into out of



(to) decide (to) let, (to) allow (to) permit



(to) understand (to) forget

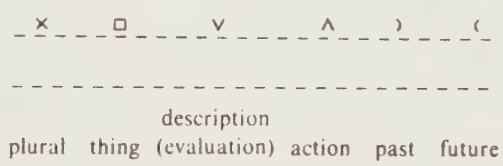
The second requirement of the personal computer is that THE BLISSYMBOLICS ALPHABET SHAPES CAN BE CHANGED with regard to size, direction or orientation,

position between earth and skyline, and position with regard to other shapes. (This often requires superimposing shapes.)

* * *

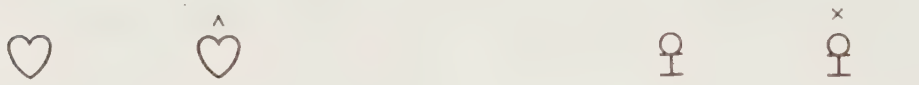
(C) In addition to the meaning which is derived from the Blissymbol alphabet shapes in their various combinations, a second level of meaning is denoted by indicators. These indicators are mini-sized symbols which are positioned above the skyline to indicate action, evaluation-description, a concrete noun, plural, verb tense, mode, voice, and a newly created symbol.

e.g.



A third requirement is that SPACE ABOVE THE SKYLINE BE RESERVED FOR THE INDICATORS even though they will only appear with some symbols.

e.g.

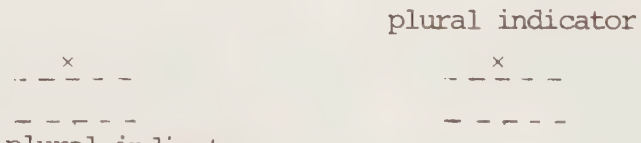


feeling (to) feel child children

* * *

(D) A fourth requirement is that SPACE BE ALLOWED FOR THE WORDS which usually accompany the symbols.

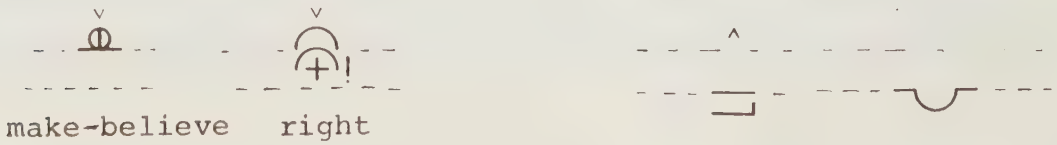
e.g.



* * *

(E) A fifth requirement is that a WAY MUST BE DEVISED TO RELATE TO THE "EXCEPTIONAL" SYMBOLS. The following are symbols which require more space that the typical symbol:

e.g.



make-believe right (to) bury hole

* * *

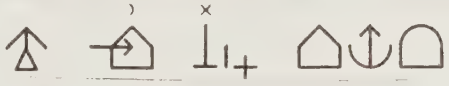
(F) Throughout, care must be taken to maintain the independence of shapes. A sixth requirement is that of ensuring that MEANING PARTS ARE CLEARLY IDENTIFIABLE.

e.g.

wheel garage

(G) Since Blissymbol messages appear in sentence form, a final requirement of the computer is that BLISSYMBOLS CAN BE PRESENTED SEQUENTIALLY.

e.g.



Mother visited our school.

E. Decide upon the Quality, Level of Resolution, Size, Number and Capabilities of Blissymbols Desired.

Depending upon your needs, decisions must be made regarding the quality of the Blissymbols presented on the computer screen. This can vary from a gross approximation of a symbol shape to shapes which approximate an exact replica of a template-drawn symbol. Similarly, the size and number of symbols you may require at any one time must be projected. The degree of resolution of which the personal computer is capable will determine quality, size, number of symbols.

In evaluating the graphics capability of a computer, three questions must be asked:

1. What are the graphics capabilities of the computer as it is purchased?
2. What graphics capabilities can be acquired through the addition of a peripheral device and at what cost?
3. What are the graphics capabilities which can be added through innovative software programs?

For displaying Blissymbols, the greater the number of dots (points on the screen) which can be devoted to the individual symbol, the better the representation. Thus the greater the number of dots which can be provided on the screen and controlled through the graphics firmware, the better and greater the number of symbols that are possible.

Table III presents the number of dots over which the user can exert control, the number of pre-programmed shapes, and the colour capabilities, within

several personal computers currently available (i.e. the graphics capabilities of the computer as it is purchased).

Insert Table III here

The possibility of adding a more extensive graphics capability can also be considered. If other features of a particular personal computer make it the most appropriate purchase, a peripheral device providing high density graphics can be added to any personal computer.[3]

As well, software programmes can be developed and added by those creative and experienced in programming. These programmes utilize the computers capabilities in innovative ways and provide easy access to Blissymbol component shapes. More with regard to this later -

F. Discover the Extent of Usage of Particular Personal Computers Within Your Geographical Region.

After studying the five areas just discussed, you must consider one further important factor: Blissymbolics on the personal computer at this time, require supportive software programs. In spite of the computer's capability for displaying Blissymbols, if the software is lacking, you will not have symbols to work with! Without the innovative programming of computer hobbyists, you would be faced with the mammoth task of starting at the beginning to design programs which could develop efficient ways of producing Blissymbols.

Different regions will have strong programs for particular personal computers. Discover which personal computer in your region is best supported by software, the interest of hobbyists, and clubs of users. Consider this in making your decision.

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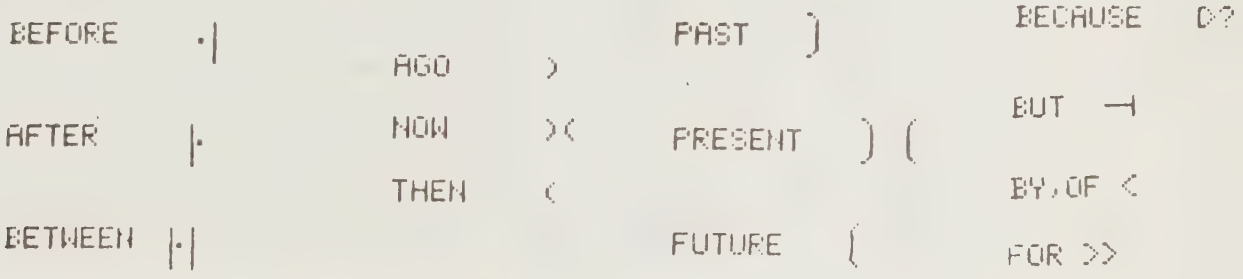
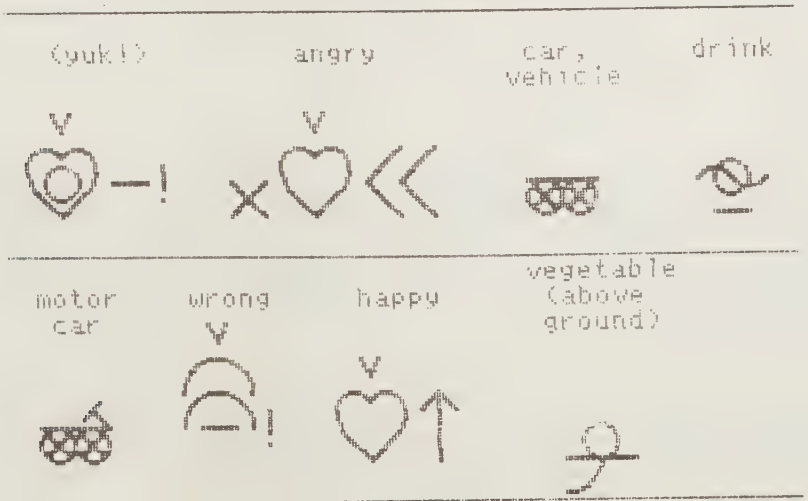
[3] One such model is called the G-Box and is produced by Objective Design Inc., P.O. Box 20325, Tallahassee, Florida, 32304, U.S.A.

Hobbyists are already involved in designing Blissymbol programs, and the examples which follow give a glimpse of the software you can look to in the future:

Bob Drake (Note 2), using the PET and BASIC language is developing a cassette software program which will allow the user to construct Blissymbols from the pre-defined shapes provided in his program. These shapes have been constructed from the PET's built-in graphics characters. Through this program which could be designated a "designer program", the user can build a set of shapes through making the shape on the screen, having the shape analyzed by the program, and entering the shape into memory. The program allows you to make a permanent copy, to recall the shape at any time you want, to overlay it and to modify it with other shapes. As the following examples of PET Blissymbols show, we will likely see developing, "dialects" of Blissymbolics, influenced by the computer on which they are created.



Gregg Vanderheiden (Note 3), is using the APPLE and BASIC language to design floppy disk software which will demonstrate the potential of the APPLE to display Blissymbols with the same resolution (and using the same data storage system as the Blissymbol printer [Kelsoe & Silverman 1977]). In this program an APPLESOFT shape table is created and shapes are manipulated using the APPLE's high resolution graphics to produce symbols occupying a total grid (symbol and word) of 72 dots in height and 56 dots in width. The user can draw his/her own symbols, and can position 12 average-sized symbols on the screen at a time. With this spacing, a full symbol space is provided above, and a half symbol height is provided below the main symbol to allow for symbols which go above the skyline and below the groundline, including markers.

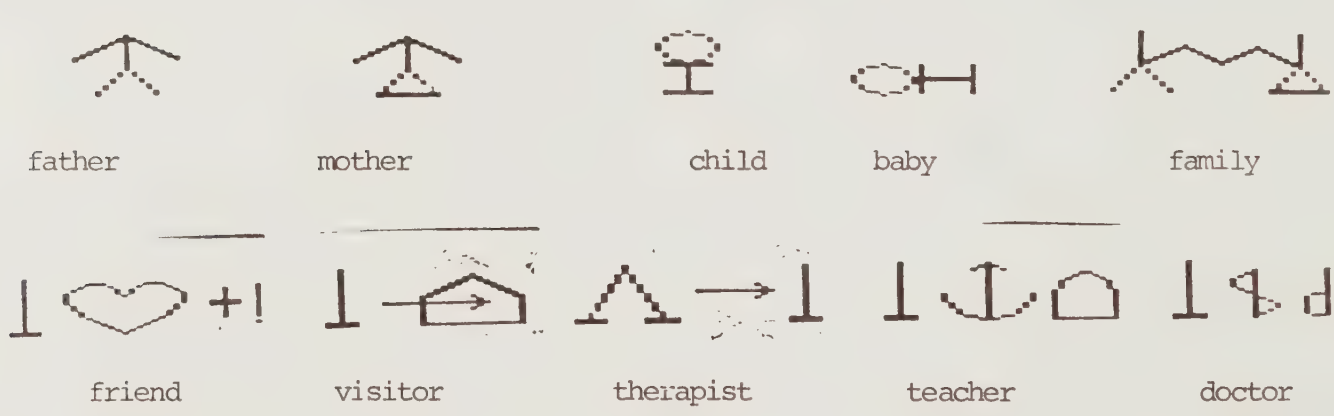


Bob Papp (Note 4) is using the APPLE and PASCAL language to produce floppy disk software which allows the user to draw symbols which in appearance approximate those which are template-drawn. This program permits a symbol to be positioned at any point on the screen and of a scale (size) determined by the user.

EXAMPLE AVAILABLE ON APPLE FLOPPY DISK.

See Appendix B

Interactive Systems (Bodner, Hollen & Zogby, 1978), using the APPLE and BASIC language have designed a floppy disk software program using low resolution colour graphics. Symbols can be generated at high speed and appear one at a time on the screen, scrolling through 200 symbols. The computer is controlled by the closing of a single contact switch, and timing of the scroll can be individually determined. Although the symbols have quite a crude representation because of the low resolution graphics, they were found to be recognizable by the users with whom the program was tested. This is the first documented Blissymbol program for a personal computer.



From the examples just shown, the range in quality of symbol presentation is very evident. The following are specific examples of Blissymbols which will allow you to compare various personal computers as to their capabilities in presenting Blissymbols. Consider them to be your "benchmarks"[4] (evaluate

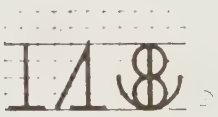
[4] "benchmark programs" - A program which is representative of the type of work your system will be required to do. You run it on all the different systems being evaluated and compare how long it takes (and for Blissymbols, evaluate the quality of the symbol which is produced).

as to quality as well as to speed) and before deciding upon a particular personal computer, find out how the following Blissymbols could be presented on the screen and how long each one will take. Check with the Blissymbolics Communication Institute to learn about software that may be available to help you.

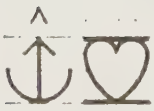
teenager, adolescent

visitor, guest

right (morally), good

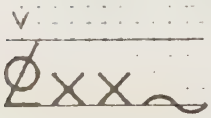


clerk

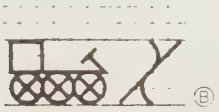


(to) comfort (to) console

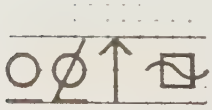
ambulance



salty (taste)

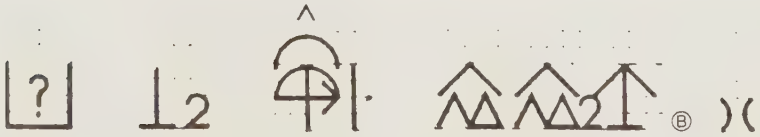


fire truck



ice cream

garage



Do you forgive (your) cousin now ?

And here are some specific questions you should ask:

1. What size(s) of symbols is (are) feasible?
2. How many symbols at one time can appear on the screen?
3. Can words accompany symbols when required?
4. How fast will symbols be presented?
5. Are there software programs which allow you to create new symbols?
6. Can you store the new symbols you create to use again?

And one last consideration!
Think about what new things you might like to do with your Blissymbols. It may seem fanciful, but with your personal computer, you can make your symbols move; flash on and off; change in size and colour; fade into one another; make a planned appearance and disappearance! Some of the things that signers have long been able to do through AMESLAN, you can now accomplish with a personal computer. You can show intensity, repetition, importance, direction, dominance. Will we call it Blissymbol art, or poetry, or just a new way of constructing Blissymbol messages? Personal computers spark the imagination! Thompson (1978) suggests a "time-varying icon" creating a "symbolic movie". "Colour, size, and rate of transformation from one symbol to the next then become variables under the command of the author." (p. 49) What <u>will</u> be the form of Blissymbolics messages in the eighties?

You will observe, that in all the information presented in this paper, no mention has been made of the cost of personal computers. This has been a purposeful ommission for several reasons:

- prices vary from one location to another;
- prices change over time;
- the personal computer along with peripheral devices can take many forms and the total price can vary greatly.

But most importantly, price has not been discussed in this paper, for it should <u>not</u> be a major consideration! In selecting a device which could provide your entry to new levels of communication, education, recreation and work activities, the few hundred dollars difference between models, should not be a critical factor. If you wish to make a comparison, however, Table IV allows you to do so.

It is as if, during the seventies, Blissymbolics, by its very nature a graphic system, and personal computers with their expanding graphic capabilities, have been growing and maturing, in order to form a marriage in the eighties. Those who will benefit from such a union are you, the Blissymbol user who will acquire a technology which allows heightened use of your system, and the personal computer user who will acquire your powerful communication tool.

In closing, --- advice regarding personal computers, from a Blissymbol instructor to Blissymbol users:

Become informed;
Select carefully;
Be prepared to defend your need;
and
Enjoy being involved
with
Personal Computers and Blissymbolics

* * *

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Brian Wilson, Toronto

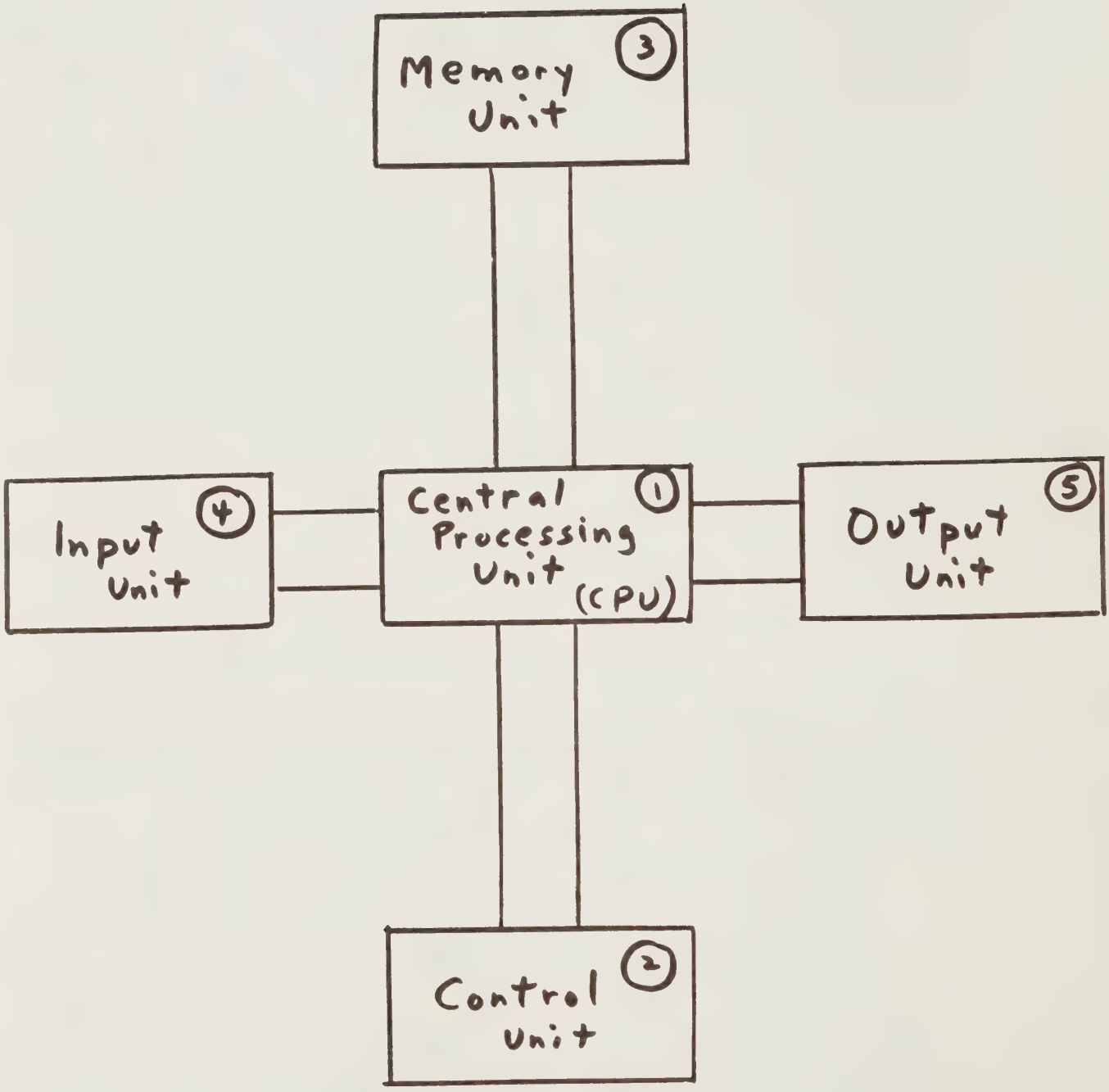

Memory Unit
3
Input Unit
4
Central Processing Unit (CPU)
1
Output Unit
5
Control Unit
2

DIAGRAM 1.

Computer	Memory	Expansion	Audio Cassette	Disk Capacity
Radio Shack TRS-80 Level II	12K ROM (BASIC) 16K RAM (32-48K with expansion interface)	expansion interface, 1-4 disk drives, modem, voice synthesizer, printers	500 baud, motor control	drive 1 - 56K drive 2, 3, 4 - 82K
Apple II	12K ROM (BASIC, monitor) 16-48K RAM	8 general-purpose I/O slots for disks, printers speech boards, clocks, etc.	1200 baud	108K, 4 drives
Commodore PET	14K ROM (BASIC and OS) 8-32K RAM	IEEE-488 Bus, printer	500 baud (?)	?
Compucolor II	16K ROM (BASIC, DOS, CRT mode) 8-32K RAM	2nd disk drive expanded keyboards	no (floppy disk built-in)	51K, 2 drives
Atari 800	8K ROM internal 8-32K cartridge 8-48K RAM	printer, disks, modem	600 baud	80K, 4 drives
TI 99/4	26K ROM internal 30K ROM cartridge 16K RAM	speech synthesizer, modem, printer, cassette recorder, disk drives	optional, 1300 baud	80K, 4 drives

TABLE 1

Space available within the computer and means of accepting programs from storage peripherals.

from North, S.
Personal Computer Comparison Chart.
Creative Computer , Nov. 1979 5, #11, 30-31

Computer	I/O Ports built-in
Radio Shack TRS-80 Level II	none
Apple II	game paddles
Commodore PET	parallel port
Compucolor II	RS-232
Atari 800	game paddles, light pen
TI 99/4	general-purpose I/O port, RS-232 option

TABLE 2.

Input/Output ports, built-in.

from North, S. Personal Computer Comparison Chart. Creative Computing, Nov. 1979. 5, #11, 30-31.

Computer	Number of dots colour & character capabilities
Radio Shack TRS-80 Level II	48 *128 black & white
Apple II	low resolution 40*40, 16 colours high resolution 280*160, 6 colours high resolution 2 280*192
Commodore PET	64 graphics characters black & white
Compucolor II	128*128, 8 colours 64 graphics characters
Atari 800	380*192, 16 colours
TI 99/4	192*256, 16 colours

TABLE 3

Graphics Capabilities

from North, S. Personal Computer Comparison Chart. Creative Computing, Nov. 1979, 5, #11, 30-31.

Computer	Price (16K RAM) American
Radio Shack TRS-80 Level II	$849
Apple II	$1195
Commodore PET	$795
Compucolor II	$1695
Atari 800	$1000
TI 99/4	$1150

TABLE 4

Prices of several personal computers.

from North, s. Personal Computer Comparison Chart. Creative Computing, Nov. 1979 5, #11, 30-31.

Appendix A

References relating to the use of computers by handicapped persons.

Bodner, M. & Hoelen, G. Blissymbolics Utilizing a Modern Microcomputer System or an Interactive Language for the Severely Handicapped. NCC Personal Computing Digest, 1978.

Ciarcia, S. Computerize a Home. Byte, January, 1980, 5, #1.

Costlow, T. The Handicapped Byte Back. Interface Age, Aug/Sept., 1979, 4, 40-42.

Drake, R. Micro helps TMR education in Brant. ECOO, Feb. 1980, 1, #2, 15-16.

Galbraith, G. An Interactive Computer System for Teaching Language Skills to Deaf Children. American Annals of the Deaf, Oct. 1978.

Giddings, W., Norton, J., Nelson, P., McNaughton, S., & Reich, P. Development of a Blissymbol Terminal: an Interactive TV Display to Enhance Communications for the Physically Handicapped. Reprinted from the proceedings of the Sixth Man-Computer Communications Conference, May 29-30, 1979, Ottawa.

Goldenberg, E. Paul. Special Technology for Special Children. Baltimore: University Park Press, 1979.

Jung, P. New Learning Aids Offer Help for the Handicapped. Apple, 1979, 1, #1.

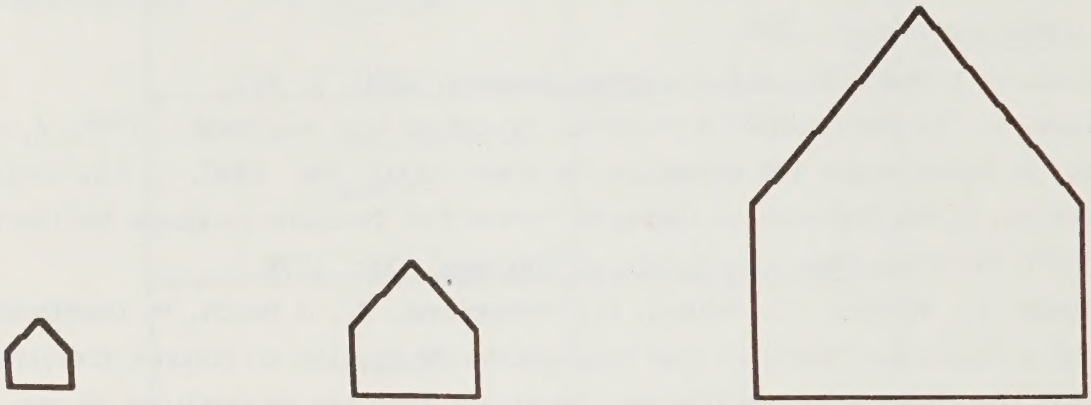
Macleod, I. Computer Assisted Teaching with the Intellectually Handicapped. Report on program at the Woden School, Deakin, ACT, Australia. Available from the Dept. of Engineering Physics, The Australian National University, Canberra, ACT, 2600, Australia.

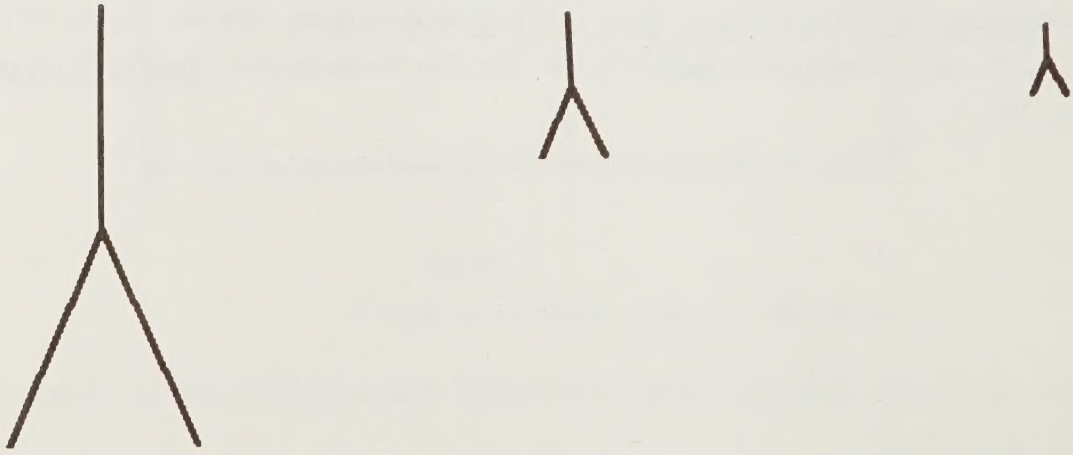
McNaughton, S. Technical Aids in Blissymbol Communications. Proceedings of the Workshop on Communication Aids for the Handicapped. Ottawa, June, 1977.

Scully, T. Microcomputer Communication for the Handicapped. People's Computers, 6, #5.

Appendix B

EXAMPLE OF BLISSYMBOLS AS THEY MIGHT APPEAR ON APPLE II





References

Bliss, C.K. Semantography/Blissymbolics. Sydney, Australia: Semantography Publications, 1965.

Bodner, M. & Hoelen, G. Blissymbolics Utilizing a Modern Microcomputer System or An Interactive Language for the Severely Handicapped. NCC Personal Computing Digest, 1978.

Dwyer, T. & Critchfield, M. Basic and the personal computer. Reading, Massachusetts: Addison-Wesley Publishing Company, 1978.

Eulenberg, J. & Vanderheiden, G. We are a Community. Communication Outlook, 1978, 1, #1.

Gotlieb, C.C. Computers in the Home: What they can do for us - and to us. Occasional Paper No. 4. Institute for Research on Public Policy, August, 1978.

Hehner, B. (Ed.), Blissymbols for use. Toronto: Blissymbolics Communication Institute, 1980.

Helmers, C. The Era of Off-the-Shelf Personal Computers Has Arrived. BYTE, 1980, 5, 6.

Kates, B. & McNaughton, S. The first application of Blissymbolics. Toronto: Blissymbolics Communication Institute, 1975.

Kelso, D. & Silverman, H. The Bliss-com: a portable symbol printing communication aid. Proceedings, Fourth Annual Conference on Systems and Devices for the Disabled, June, 1977, 99.

Lundman, M. Technical aids for the speech-impaired. Stockholm: ICTA Information Centre, 1978.

McNaughton, S. Blissymbolics. Paper presented at the Council for Exceptional Children, 3rd National Congress, Winnipeg, Manitoba, October, 1978.

McNaughton, S. & Kates, B. The application of Blissymbolics. In R.L. Schiefelbusch (Ed.), Nonspeech language and communication analysis and intervention. Baltimore: University Park Press, 1980.

North, S. Personal Computer Comparison Chart. Creative Computing, 1979, 5, 30-31.

Preston, J., Jr. Assessment of Needs for Control and Interfaces to Operate Assistive Devices for the Severely Disabled. Stanford: Rehabilitation Engineering Center, Children's Hospital, 1979.

Silverman, H., McNaughton, S. & Kates, B. Handbook of Blissymbolics. Toronto: Blissymbolics Communication Institute, 1978.

Thompson, G. Memo from Mercury: Information Technology is Different. Occasional Paper No. 10. Institute for Research on Public Policy, June, 1979.

Vanderheiden, G.C. & Grilley, K. Non-verbal communication techniques and aids for the severely physically handicapped. Baltimore: University Park Press, 1976.